ENVIRONMENTAL OFFSETS:
Reservoir Hill 2024 Ecological Monitoring Results

Advice for management of Golden Sun Moth Habitat on Reservoir Hill (Lawson South)

Image: Monitoring point on Reservoir Hill (credit: Thea O'Loughlin)

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We acknowledge the Ngunnawal people as traditional custodians of the ACT and recognise any other people or families with connection to the lands of the ACT and region. We acknowledge and respect their continuing culture and the contribution they make to the life of this city and this region.

Contents

Executive Statement

The 2024 ecological annual monitoring program of Reservoir Hill, as per the Environmental Management Plan, was completed successfully. The ecological monitoring outcomes presented herein have been circulated to the relevant land managers to inform future planning and appropriate management actions that may need to be undertaken over the next 12 months. The following report is not comprehensive; it is a rapid snapshot aimed to highlight potential issues and initiate discussions about feasible land management interventions for the site. It should be noted that climate has a considerable influence on results and the results presented herein may be a product of climatic condition rather than a response to management practices. Equally, management actions may have been required but unable to be implemented due to weather and related logistical constraints. Some results also reflect a short-term response to management actions, such as an eco-burn, and should be interpreted with this in mind.

Key results for the season include:

- Golden Sun Moth (GSM) were recorded in low numbers. The number of individuals recorded in 2024 was an improvement on 2023 when no individuals were recorded.
- Floristic diversity and the percentage ground cover of native plants overall was moderate with some areas meeting benchmarks for *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) Natural Temperate Grassland (NTG) quality.
- Grass height was within benchmark range across the site, suggesting there has been appropriate herbage mass management applied throughout the year.
- GSM food-species cover was below the recommended benchmark for GSM habitat across the site.
- Thatch cover and depth was moderate and without concern. This is expected from a dry season following 3 years of above average rainfall.
- Bare ground was almost absent at the site and did not meet benchmark for either GSM habitat or NTG.
- Exotic species cover (non-native ground cover) was above previous levels and above the recommended benchmark.
- African Love Grass (ALG), Serrated Tussock (ST) and St John's Wort (SJW) were mostly within containment or local eradication levels suggesting eradication of these weeds is reasonably possible at the site with appropriate management and investment in weed control.

Acronyms

Acronym	Meaning
ALG	African Lovegrass
CNG	Chilean Needle Grass
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
FVS	Floristic Value Score
GSM	Golden Sun Moth (*Synemon plana*)
MNES	Matters of National Environmental Significance
NR	Nature Reserve
NTG	Natural Temperate Grassland
PCT	Plant Community Type
PMR	Planning, Monitoring and Research
SJW	St John's Wort
ST	Serrated Tussock

Background

Transport Canberra and City Services (TCCS) within the City and Environment Directorate is the primary land manager of Reservoir Hill Golden Sun Moth (GSM) Habitat Protection Area (Figure 1). To meet development approval commitments and to allow for adaptive land management, TCCS previously engaged external consultants to undertake ecological monitoring of the site and provide advice (Rowell (2016, 2017, 2018, 2019, 2020); Umwelt (2021); Farrow (2024)). In 2024, an agreement between TCCS and ACT Parks and Conservation Service (PCS) was established to hand monitoring of ecological values and reporting commitments of Reservoir Hill to the PCS Environmental Offsets Planning, Monitoring and Research (Offsets PMR) team. The Offset PMR team has established a comprehensive monitoring program at sites within (and contiguous to) environmental offset areas across the ACT. A team of in-house ecologists facilitate and coordinate the monitoring and adaptive management of the sites and associated biodiversity values with data collected for a range of metrics that inform ecological condition and health. Results for each ecological metric can be compared against identified benchmark levels, and values outside of these levels can trigger discussions for appropriate management interventions. For more detail about the monitoring program and methods undertaken by the Offsets PMR team, refer to the inaugural report **(**Environmental Offsets Ecological Monitoring Program Report 2018-19**)**.

In spring and summer of 2024, the Offsets PMR team undertook the required ecological monitoring at Reservoir Hill GSM Habitat Protection Area in line with EPBC Act commitments for the site.

Figure 1. Overview map of Reservoir Hill GSM Habitat Protection Area.

Report Purpose and Scope

This report focuses on a snapshot of monitoring data collected between September and December 2024. It presents basic information at a site level to give a quick insight into selected ecological condition metrics for flora and fauna and puts forward advice for management of the site. The monitoring data presented includes:

Flora:

- FVS, non-grass species, indicator species, percentage of perennial cover that is native and percentage cover of GSM food species as a measure of diversity and site quality.
- Vegetation structure (average grass height, average thatch depth, bare ground cover) as a measure of herbage mass/biomass levels.
- Weed density presented by the number of plants per hectare for target weed species.

Fauna:

- GSM population abundance and distribution.

The purpose of the information presented herein is to:

- Contribute to data informing ecological condition of MNES and associated broader biodiversity values at each monitoring site.
- Compare annual monitoring metrics against defined benchmark values for vegetation condition and fauna habitat quality.
- Trigger discussions for potential management actions and support land managers in evidence-based decision-making to maintain and/or improve ecological condition.

This report is not comprehensive; it is a rapid snapshot aimed to highlight potential issues and initiate discussions about feasible land management interventions for a given site. Monitoring plots are stratified across the different ACT vegetation zones at the site and this program is designed to capture general ecological trends, potential ecological issues that can be actioned through management, and the effect of management actions. Given that the ecological monitoring outcomes presented herein were undertaken in spring and summer 2024, this report does not necessarily reflect the appropriate management actions that may have been undertaken in recent months, or that are planned to be undertaken over the next 12 months (e.g. weed control, mowing and ecological burns). It is important to note that effective management may have occurred at a given site since these results were collected and results outside of benchmark may have already been, or will be, dealt with appropriately by the respective land manager.

Survey Methods

Golden Sun Moth

Population surveys of GSM were undertaken along 43 permanent 50m transects, covering 2.15kms (Figure 2). Transect locations surveyed were chosen based on where historic surveys had been conducted almost annually since 2016 (e.g. Rowell (2016, 2017, 2018, 2019, 2020); Umwelt (2021)). Some transects had historical records dating back to 2012. GSM were surveyed by walking the length of transects and recording all moths seen within 25m each side of transect line. Surveys were conducted during ideal flying conditions as outlined in monitoring guidelines for this species (see Commonwealth of Australia 2009). In 2024, surveys were undertaken four times during the flying season by ecologists experienced in the identification of GSM from Capital Ecology.

Figure 2. Map of Reservoir Hill showing survey effort including Golden Sun Moth transect locations and segments, and vegetation sampling locations.

Vegetation Surveys: Plant Species Composition

Plant species composition, or floristics, was measured in five fixed 400m^2 plots in October and surveyed following ACT Government guidelines (see ACT Government 2015a; ACT Government 2015b). Within these plots, all plant species present were identified, and a score was assigned following the Braun Blanquet abundance/cover system (see Rehwinkel 2015). Using the plant species categorisation system developed by Rehwinkel (2015), various metrics were calculated for each plot from this data: native species richness, exotic species richness, number of indicator species (grasslands) and a FVS.

Vegetation Surveys: Ground Vegetation Cover and Structure

Vegetation cover was estimated at five plots in spring using a point-step method, with 75 points measured per 400m^2 plot. At each point (1 cm^2) the dominant ground cover was recorded from the following categories: native grass – *Rytidosperma spp*.; native grass – C3; native grass – C4; native ground – shrub; native ground – other; exotic – perennial grass; exotic – annual grass; exotic – broadleaf; exotic – clover; rock; bare ground; cryptogram; thatch; leaf litter; other. Where two cover metrics (e.g. bare ground and thatch) were present in equal proportion, both measures were recorded for that step. Native cover and exotic cover values were used to calculate proportion native cover for each plot. Average grass height (cm) and average thatch depth (cm) were estimated within 10 x 26cm radial, randomly selected quadrats within the vegetation plot.

Vegetation Surveys: Weed density

The density of five important weed species was estimated using a distance method. These species are: ALG, Chilean Needle Grass (CNG), ST, Saffron Thistle, and Patterson's Curse. From the centre of each of the five permanent vegetation plots, the distance to the nearest three individuals of each of the five weed species was measured. Weeds located further than 15 m from the centre point were not included; which results in zero to three distance measures for each weed species in each plot. The weed distances were calculated into an estimate of density using a variable area method to estimate the number of plants per plot area. This method was validated by running multiple simulations of weed densities in clumped and random patterns. The resulting evaluation suggested density estimate was within 15% of true density. More detail on this simulation exercise and how results were used to inform weed density estimates will be reported on separately.

Plant Community Types

For this site, flora results have been presented for each Plant Community Type (PCT) at a vegetation zone level. These zones characterise areas by floristic diversity, native cover and woodland structure and relate to the EPBC listed ecological vegetation communities (NTG and Box Gum Woodland (BGW)). The vegetation characteristics for each zone within a PCT are summarised in the table below (Table 1).

Table 1. Tablelands Dry Tussock Grassland ACT01 Vegetation Zones

Vegetation Zone ID	Percentage Native Cover	Native Forb Diversity
1.1 (EPBC Natural Temperate Grassland)	>50%	High (>6.5 FVS)
1.2 (EPBC Natural Temperate Grassland)	>50%	Moderate
1.3 (Non EPBC Native Pasture)	<50%	Low (<5 FVS)
1.4 (Non EPBC Exotic Pasture)	<50%	N/A

Benchmark Targets

Results for each ecological metric are compared against the pre-defined benchmark levels for each ecological community, where available (Table 2). Benchmark values represent reference state conditions for which to compare our sites to assess quality and provide targets to guide vegetation management and restoration activities. These levels for comparison are intended to be dynamic and will be subject to change over the course of the monitoring program to better reflect sensible target conditions. Baseline values for all metrics will be collected from 2024 to 2026 to provide site specific context to assess improvement or decline and inform management.

Vegetation Benchmarks

Table 2. Vegetation benchmarks for GSM habitat. * Refers to GSM specific benchmarks as outlined in Rowell (2013). ^ Indicates EPBC metrics for vegetation community listing. The other benchmarks are Offsets PMR-selected benchmarks for management of NTG.

Metric	Benchmark
Native C3 perennial grass cover (i.e. wallaby grass, spear grass)*	55-65%
Bare ground cover*	5-15%
Thatch cover*	5-15%
Exotic species cover*	<5%
Floristic Value Score^	≥5
Non-grass species richness^	≥8
Indicator species richness^	>2
Native perennial cover (<1m height) (%)^	≥50%
Average grass height (cm)	5-12 cm
Average thatch depth (cm)	<1 cm
ALG density (plants per ha)	<50
CNG density (plants per ha)	<50
SJW density (plants per ha)	<50
ST (plants per ha)	<50

Weed Density

Weed density data is collected for invasive plants that are considered "transformer weeds" or are of concern in the ACT. The weeds reported on here are ALG, CNG, ST and SJW. Management guidelines recommend different approaches depending on the number of plants per hectare (Table 3, Table 4), however, a benchmark of **<50 plants per hectare** is used in this report.

EPBC plant community:

Table 3. Management guidelines for varying densities of weeds in an EPBC listed plant community

Plants per hectare estimate	Management Approach
0	Prevention
1-500	Extirpation (aim for local eradication)
>500	Asset Protection

Non-EPBC plant community:

Table 4. Management guidelines for varying densities of weeds in a non-EPBC listed plant communities

Plants per hectare estimate	Management Approach
0	Prevention
1-100	Extirpation (aim for local eradication)
100-1000	Containment
>1000	Asset Protection

Seasonal Context and Limitations

When interpreting the results of this monitoring season, the strong influence of climatic variation must be considered. The long-term mean annual rainfall is 648.1 mm as reported for the Canberra Airport site by the Bureau of Meteorology (BOM 2025). In 2024, Canberra Airport recorded 567.8 mm of rain (BOM 2025). Notably, in the five months leading up to vegetation and GSM monitoring Canberra received less than half of the average rainfall over this time (Figure 3, BOM 2025b). This comes after four years of above average rainfall over which, at many offset sites, exotic species became more dominant, biomass increased and native species diversity increased relative to the drought years of 2018 and 2019.

As such, changes in ecological condition may be a product of climatic condition rather than a response to management practices. It also highlights the need to carefully balance the recommended timing of management actions with the available weather windows to maintain appropriate biomass levels.

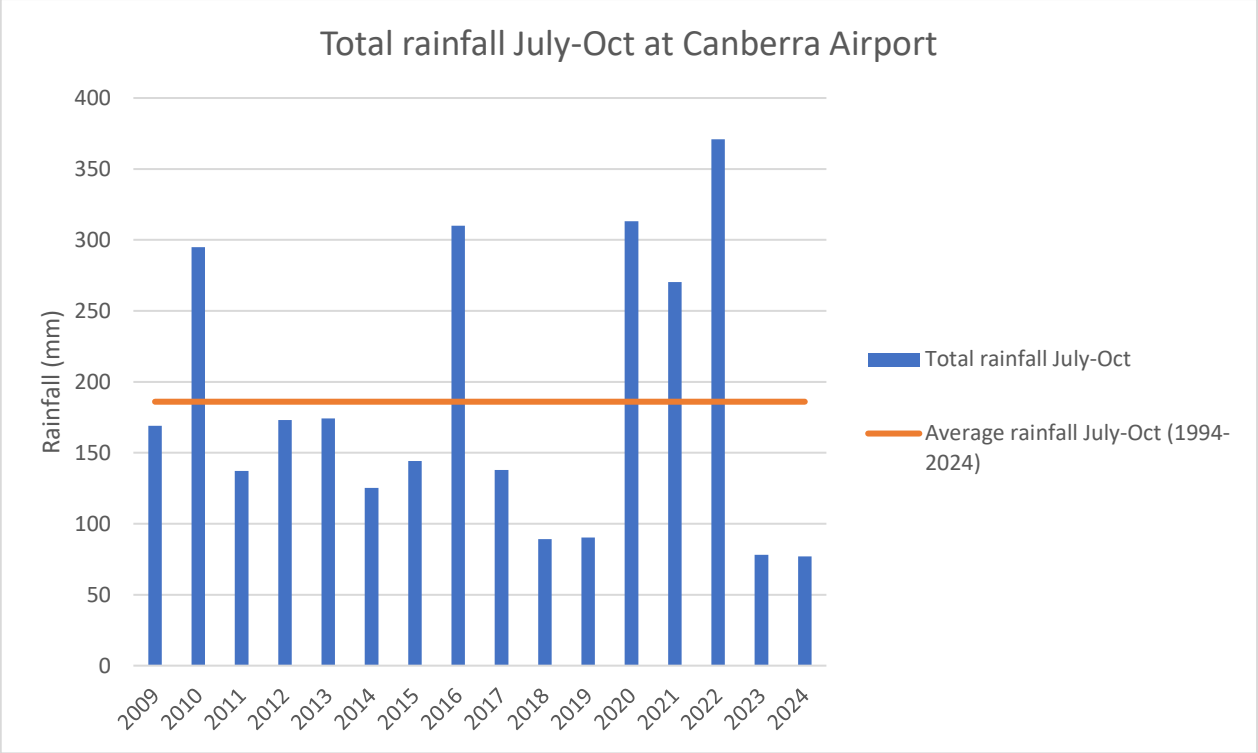

Figure 3. Total rainfall observations for the months July-Oct over the previous 15 years and the average over the past 30 years. Observations come from the Canberra Airport weather stations 070351 and 070014 (BOM 2025, BOM 2025b).

Results

Fauna Results

GSM were recorded on the eastern, southern, and western areas of the site, including areas not mapped as GSM habitat, in May 2024. On average there were 0.12 moths per transect (Table 5). Of the 43 transects surveyed, 5 were occupied. Both male and female moths were sighted during the surveys. The highest number of GSM detected in a single day of surveys was 3. This is low compared to previous years, despite good survey conditions and appropriate biomass levels, however, it is an improvement on 2023 which recorded zero GSM (Figure 4). In wetter and cooler years, it is not unusual to have low records of GSM, as was seen across the ACT in 2020, 2021 and 2022. Further monitoring in spring/summer 2025 will help confirm the status of GSM at Reservoir Hill.

Table 5. Golden Sun Moth survey results for Reservoir Hill in 2024

Fauna Metric	2024	Survey Notes
Density of GSM per transect ± standard error	0.12 ± 0.05	Good survey conditions.
Number of transects surveyed for GSM	43	Normal number of transects.
% transects occupied by GSM	12%	Good survey conditions.
Max number of GSM counted in one day of surveys	3	

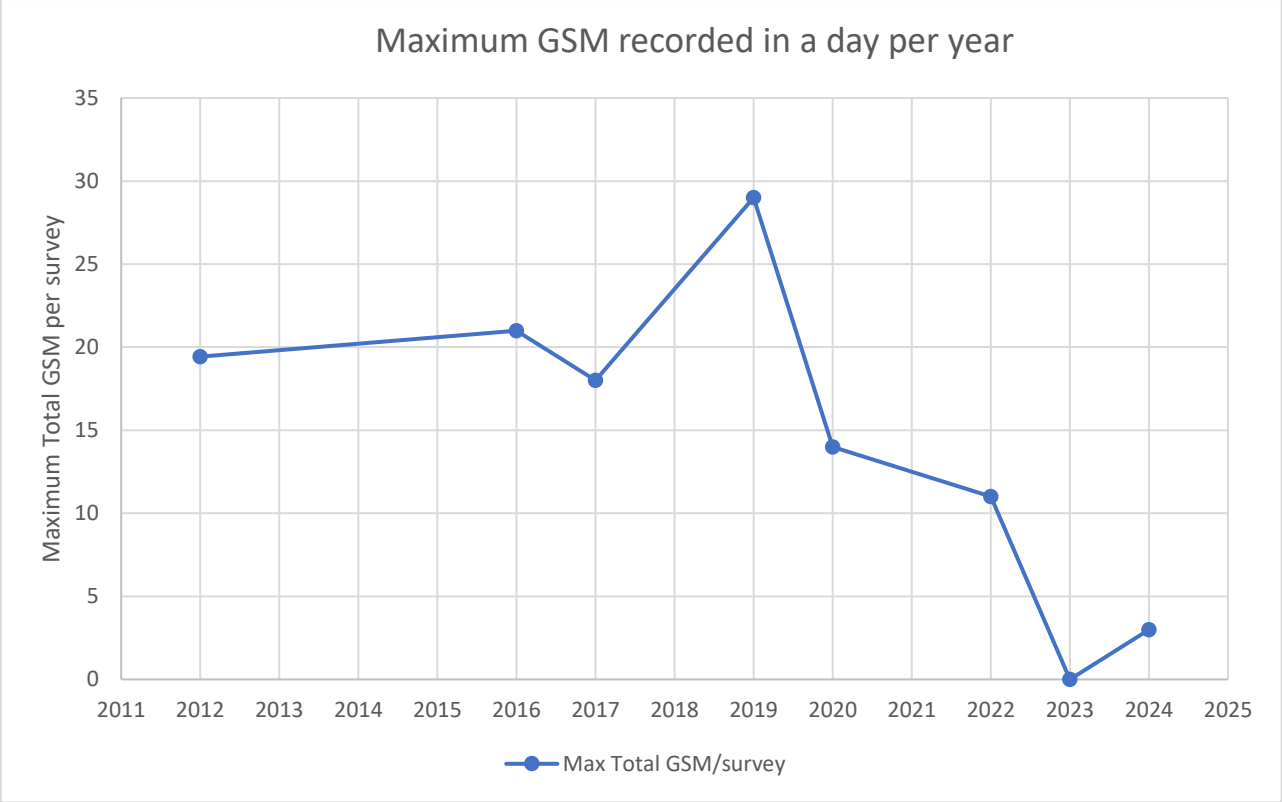

Figure 4. Results of GSM monitoring since 2012. Note that the method differed in some years so only a broad trend can be inferred. Most years of monitoring consisted of four checks of between 1.7-2.15km of transects. The Max Total GSM/Survey gives the results from the best day of surveys. It is generally a better metric than the average for comparing between years due to differing survey periods between years.

Vegetation Results

Vegetation results are summarised for the three areas shown in Figure 5.

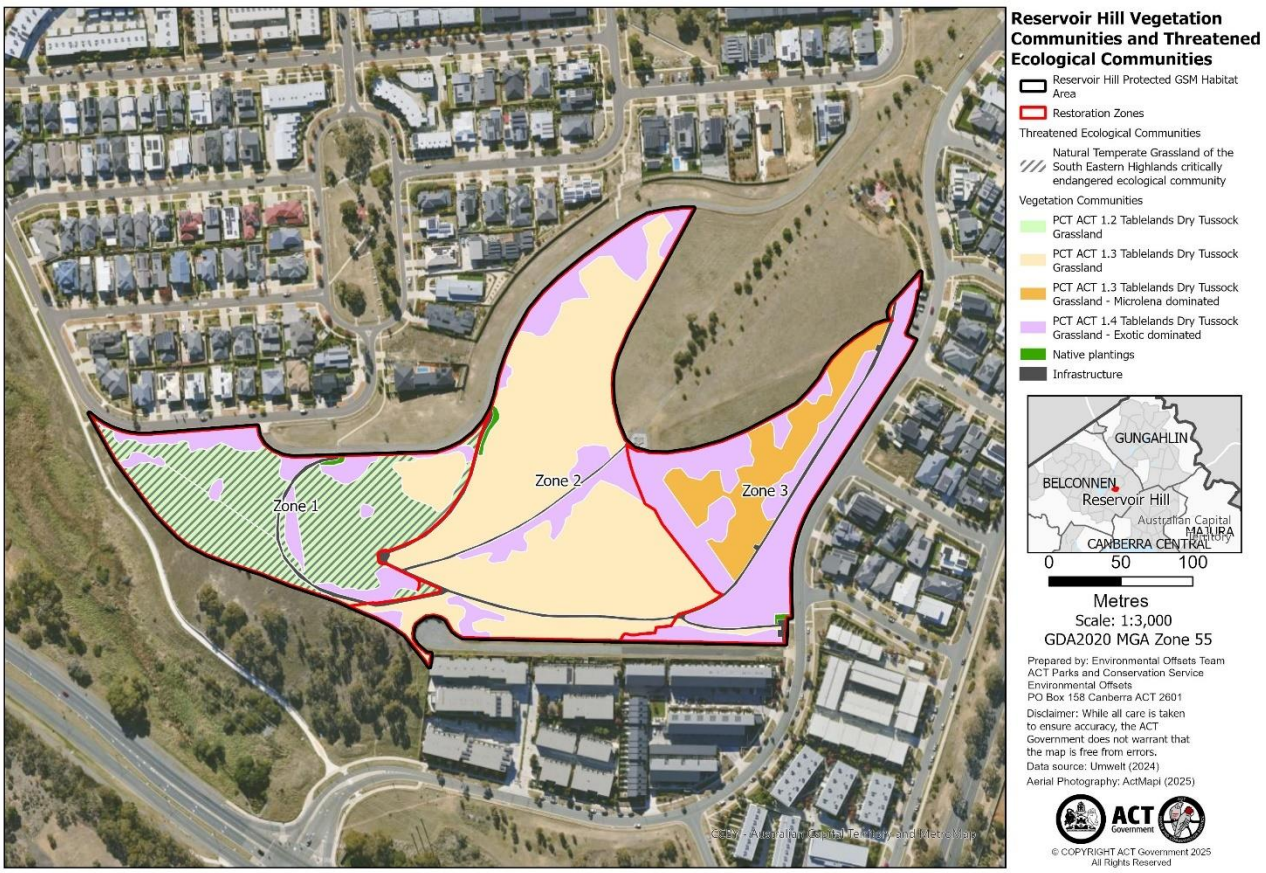

Figure 5. Map of Reservoir Hill showing the three management/restoration zones, vegetation communities, and PCT types across the site as mapped by Umwelt in May 2024 (Umwelt, 2024).

Zone 1 – High diversity, high quality GSM habitat area in the west of the site.

- Floristic diversity metrics met the definition for EPBC listing as NTG
- Native cover was relatively high
- Wallaby grass and spear grass cover was below the lower benchmark for GSM habitat
- Average grass height was within benchmark range
- Bare ground cover was zero, this is below recommended benchmarks for GSM and NTG
- Measures of thatch were within benchmark range
- Exotic species cover was outside of benchmark levels
- ALG, SJW and ST densities were all high and outside of benchmark range, but within or close to the level recommended for local eradication.
- No CNG was detected.

Zone 2 – Medium-low diversity, medium quality GSM habitat area on the western and southern slopes of the hill.

- Measures of floristic diversity were below benchmark for EPBC listing as NTG
- Native cover met the benchmark
- Wallaby grass and spear grass cover was below the lower benchmark for GSM habitat
- Average grass height was within benchmark range
- Bare ground cover was below the lower benchmark
- Measures of thatch were just higher and outside the upper benchmark
- Exotic species cover was higher and outside the upper benchmark
- ALG, SJW and ST were in densities higher than recommended benchmark.

Zone 3 (Microlaena area) – Medium diversity, non-GSM habitat on the eastern slope of the hill.

- Two out of three measures of floristic diversity met the benchmark for EPBC listing as NTG
- Native cover met the benchmark
- Wallaby grass and spear grass cover was below the benchmark for GSM habitat
- Average grass height was just within benchmark range
- Bare ground cover was zero (this is below all recommended benchmarks for GSM and NTG)
- Thatch cover and depth were just outside and higher than benchmark range
- Exotic grass species cover was high and outside of benchmark range, but broadleaf weeds cover was within benchmark.
- ALG, SJW and ST were all in densities outside and higher than benchmark levels.

Table 6. Monitoring metrics for Reservoir Hill applicable NTG Vegetation Zones; showing values for mean ± standard error (number of sites (n)) for each PCT zone. Yellow cells and ** before a value indicate that a metric is outside of benchmark levels. ^ Indicates EPBC metrics for vegetation community listing.
* Indicates a metric specific to GSM habitat and benchmarks as per Rowell (2013).

Metric	Benchmark	Zone 1	Zone 2	Zone 3
Floristic Value Score^	≥5	12.9 (1)	**3.6 ± 0.9 (3)	6.2 (1)
Non-grass species richness^	≥8	8 (1)	**3 ± 0.6 (3)	**5 (1)
Indicator species richness^	>2	7 (1)	**1.7 ± 0.3 (3)	3 (1)
Native perennial cover (<1m height) (%)^	≥50%	82.8 (1)	72.5 ± 4.3 (3)	55.9 (1)
Wallaby grass cover		33 (1)	4 ±2.3 (3)	3 (1)
Wallaby grass and spear rass (%)*	55-65	**33.3 (1)	**23.6 ±7.5 (3)	**2.7 (1)
Average grass height (cm)	5-12 cm	7 (1)	8.9 ± 0.7 (3)	11.8 (1)
Bare ground cover (%)*	5-15%	**0 (1)	**0.9 ± 0.9 (3)	**0 (1)
Average thatch depth (cm)	<1 cm	0.6 (1)	**1 ± 0.2 (3)	**1.2 (1)
Thatch cover*	5-15%	14.7 (1)	17.3 ±2 (3)	30.7 (1)
Exotic species cover*	<5%	21.3 (1)	40.4 ±4 (3)	44 (1)

Metric	Benchmark	Zone 1	Zone 2	Zone 3
Broadleaf weed cover		12 (1)	10 ±5.8 (3)	2.6 (1)
ALG density (plants per ha)	<50	**317.5 (1)	**579.3 ± 551.2 (3)	**88.3 (1)
CNG density (plants per ha)	<50	0 (1)	0 ± 0 (3)	0 (1)
SJW density (plants per ha)	<50	**233.6 (1)	**1069.3 ± 569 (3)	**5456.7 (1)
ST (plants per ha)	<50	**97.7 (1)	**107.6 ± 67 (3)	**747.2 (1)

Management Advice

Summer/Autumn: Spray exotic perennial grasses: ALG, ST, CNG, Paspalum, Cocksfoot and Phalaris, Festuca.

Mid-Late autumn: Slash the whole site with a flail mower, avoiding areas dominated by ALG (to reduce seed spread). Slash at varying heights to maintain heterogeneity e.g., 6cm and 10cm. Give enough time for thatch to break down before GSM flying season. Ideally, the majority of weed seeds will have dropped, reducing their spread by the mower.

Spring: Slash with a flail mower (likely late September) to inhibit seed set of exotic annual grasses and give good grass height for GSM emergence. May only be necessary in a reduced area depending on rainfall over winter and early spring. Likely to be most required on the southern and eastern sides of the hill.

Spray after slashing when reduced biomass gives good visibility.

Spray exotic perennial grasses: ALG, ST, CNG, Paspalum, Cocksfoot and Phalaris, Festuca, Yorkshire Fog. Also target Patterson's Curse and Saffron Thistle.

If sprayers are contracted to target only ALG, ST, CNG, request the contractors responsible for other exotic perennial grass to target the small areas between better quality patches. See Figure 6 for example.

In the event of continual wet weather. Mowing times are flexible as long as it does not occur between mid-Oct and Jan which is the GSM flying season.

If conditions for an eco-burn occur: Undertake patchy burns, follow up with weeds spraying and spread seeds of native species post-burn including:

- Appropriate wallaby grass species in Zones 2 and 3
- Red leg grass in all zones
- Windmill grass in all zones

Management plans should be reviewed annually using monitoring results, herbage mass management guidelines 2019 (draft) and in consultation with Offsets PMR ecologists.

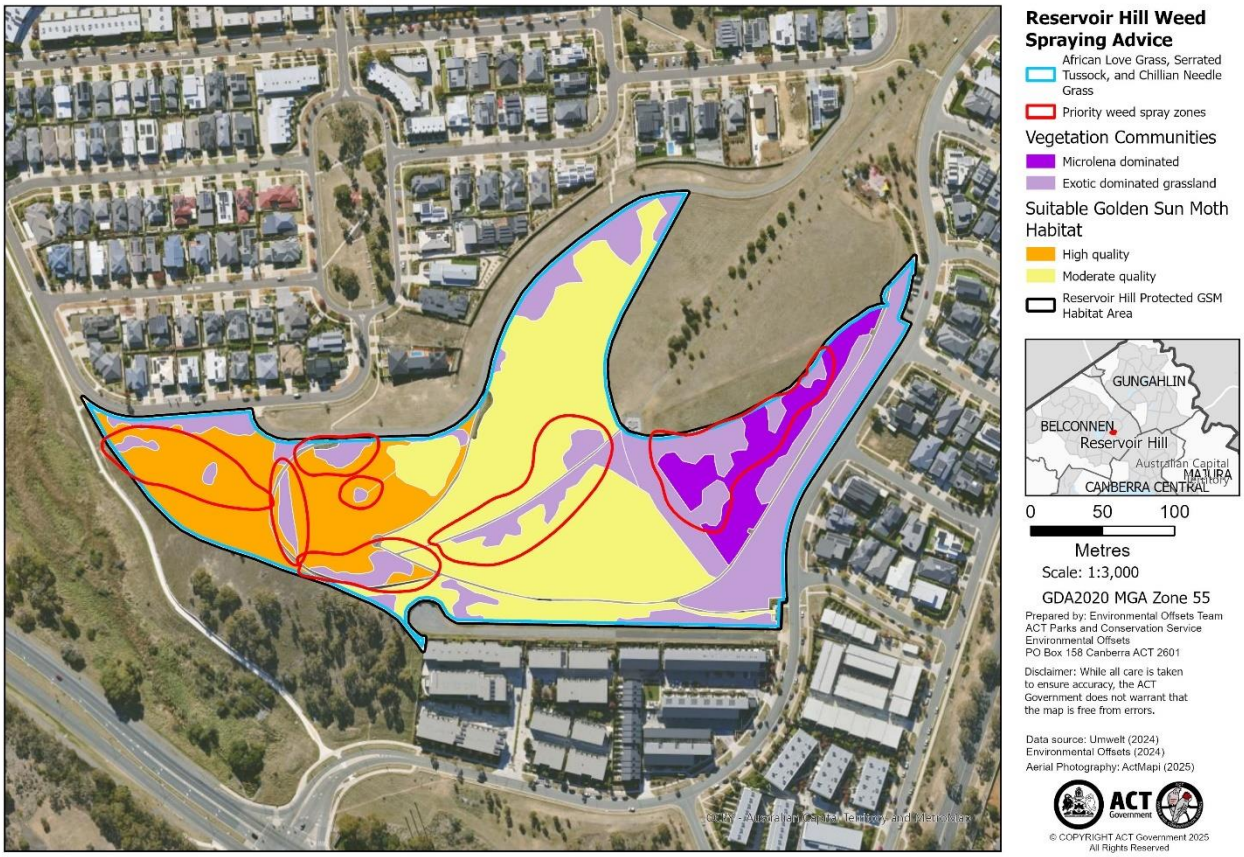

Figure 6. Map of Reservoir Hill showing areas to prioritise spraying of exotic perennial grass species circled in red. ALG, ST and CNG should be sprayed over the whole site.

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Attachment A: Species Lists from 2024 Monitoring

SPECIES RECORDED, SPRING 2024

Species Name	Native	Non-grass
Acaena sp.	Native	Herb
Anthosachne scabra	Native	C3 Grass
Aristida ramosa	Native	C4 Grass
Austrostipa bigeniculata	Native	C3 Grass
Austrostipa scabra	Native	C3 Grass
Bothriochloa macra	Native	C4 Grass
Chrysocephalum apiculatum	Native	Herb
Cynoglossum suaveolens	Native	Herb
Desmodium varians	Native	Herb
Erodium crinitum	Native	Herb
Euchiton japonicus	Native	Herb
Euchiton sphaericus	Native	Herb
Geranium solanderi	Native	Herb
Geranium solanderi	Native	Herb
Juncus filicaulis	Native	Rush
Lachnagrostis filiformis	Native	C3 Grass
Microlaena stipoides	Native	C3 Grass
Microtis sp.	Native	Herb
Oxalis perennans	Native	Herb
Poa sieberiana	Native	C3 Grass
Rumex brownii	Native	Herb
Rytidosperma auriculatum	Native	C3 Grass
Rytidosperma caespitosum	Native	C3 Grass
Rytidosperma carphoides	Native	C3 Grass
Rytidosperma erianthum	Native	C3 Grass
Rytidosperma pilosum	Native	C3 Grass
Rytidosperma racemosum var. racemosum	Native	C3 Grass
Rytidosperma racemosum var. racemosum	Native	C3 Grass
Rytidosperma setaceum	Native	C3 Grass
Schoenus apogon	Native	Sedge
Senecio quadridentatus	Native	Herb
Themeda triandra	Native	C4 Grass
Triptilodiscus pygmaeus	Native	Herb
Wahlenbergia luteola	Native	Herb
Wahlenbergia multicaulis	Native	Herb
Wahlenbergia sp. A	Native	Herb
Juncus sp.	Unknown	Rush
Aira sp.	Exotic	Grass
Avena fatua	Exotic	Grass
Briza maxima	Exotic	Grass

Briza minor	Exotic	Grass
Bromus catharticus	Exotic	Grass
Bromus diandrus	Exotic	Grass
Bromus hordeaceus	Exotic	Grass
Carthamus lanatus	Exotic	Daisy
Centaurium sp.	Exotic	Herb
Chondrilla juncea	Exotic	Daisy
Crataegus monogyna	Exotic	Shrub
Dactylis glomerata	Exotic	Grass
Echium plantagineum	Exotic	Herb
Eragrostis curvula	Exotic	Grass
Erigeron bonariensis	Exotic	Daisy
Festuca arundinacea	Exotic	Grass
Gamochaeta sp.	Exotic	Daisy
Hirschfeldia incana	Exotic	Herb
Holcus lanatus	Exotic	Grass
Hypericum perforatum	Exotic	Herb
Hypochaeris radicata	Exotic	Daisy
Linaria arvensis	Exotic	Herb
Lolium rigidum	Exotic	Grass
Nassella neesiana	Exotic	C3 Grass
Nassella trichotoma	Exotic	Grass
Paronychia brasiliana	Exotic	Herb
Paspalum dilatatum	Exotic	Grass
Petrorhagia nanteuilii	Exotic	Herb
Plantago lanceolata	Exotic	Herb
Rosa rubiginosa	Exotic	Shrub
Rumex acetosella	Exotic	Herb
Sonchus asper	Exotic	Daisy
Tragopogon sp.	Exotic	Daisy
Trifolium campestre	Exotic	Pea
Trifolium glomeratum	Exotic	Pea
Trifolium sp.	Exotic	Pea
Trifolium striatum	Exotic	Pea
Vicia sp.	Exotic	Pea
Vulpia sp.	Exotic	Grass